Geothermal Resources Council, TRANSACTIONS, Vol. 12, October 1988

GEOTHERMAL DEVELOPMENT IN HAWAII

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ABSTRACT

The State of Hawaii started a geothermal exploration program, focused in the Kilauea East Rift Zone of the Island of Hawaii, in the late 1960's. The HGP-A well was completed in 1976 and a three megawatt wellhead generator plant went on line in 1982. But until recently, commercial geothermal activity had been slow. With the completion of a Statewide geothermal resources subzone designation program in late 1984, and consolidated permit and application process in 1988, the State has set the senario for development. It is likely that 12.5 megawatts will be on line by the end of this decade and there is a reasonable prospect that 550 megawatts will be attained by the end of the century.

BACKGROUND

The 3,218 kilometer Hawaii Island chain developed in a southeasterly direction with the Island of Hawaii, at the southeast end of the archipelago, being the youngest and most volcanically active island. Because of its volcanic origin, no indigenous fossil fuel reserves exist in the chain. The dislocations that occurred in the global oil market in the 1970's were particularly critical for Hawaii which, even today, is dependent on imported petroleum for almost 90 percent of its energy needs. Over $1 billion, or more than $1,000 per resident, leaves the State annually for petroleum.

Hawaii had begun to take a serious look at its alternate energy options in the late 1960's and early 1970's. Four shallow geothermal exploratory wells were drilled in the Puna region of the Kilauea East Rift Zone in the 1960's. This exploration indicated that, if any geothermal reservoirs existed, they were at considerably greater depths and could be exploited only at great cost.

The Hawaii Geothermal Project, begun in 1972, led to the drilling of the first successful Hawaiian geothermal well in 1976. This well, HGP-A, was drilled to a depth of 1,951 meters where a bottomhole temperature, under shut-in conditions, was 360°C.

With support from the U.S. Department of Energy, the State, County and University of Hawaii completed a three megawatt wellhead generator plant at the HGP-A site in 1981. This plant has produced about 20 million kilowatt-hours net each year since it went on line. The plant has demonstrated the technical and economic feasibility of geothermal energy in Hawaii.

GEOTHERMAL RESOURCE SUBZONES

The potential for large-scale geothermal activity caused considerable public concern about its environmental effects and its impact on land use. Proper management of its limited land and the need to preserve its uniqueness yet allow for reasonable progress has been a major issue in Hawaii for many years. Hawaii became the first in the United States to enact sweeping statewide land use laws and has one of the most complex and conservative land use regimes in the world.

The existing land use categories of agricultural, conservation, rural and urban did not lend themselves nicely to geothermal development. The initial statewide geothermal resource assessment surveys indicated that the resource is most likely found in lands presently designated for conservation. These lands were intended to be preserved so any effort to use them for geothermal development activity would be met with opposition.

In 1983, Hawaii's State Legislature enacted the Geothermal Resource Subzone Assessment and Designation Law (Act 296, SLH

1983) which stated that the development and exploration of Hawaii's geothermal resources is of statewide benefit, and that this interest must be balanced with preserving Hawaii's unique social and natural environment.

The law mandated the establishment of geothermal resource subzones within which geothermal development activity could take place. No geothermal development activity could take place outside of a subzone. The subzones were to be, in essence, an overlay zoning. The Board of Land and Natural Resources (BLNR) was required to assess the State on a County-by-County basis to examine factors including but not limited to:

- o Potential for geothermal energy production
- o Use of geothermal energy in the area.
- o Geologic hazards.
- o Social and environmental impacts.
- o Compatibility with present and permitted land uses.
- o Potential economic benefits.

Two parcels totalling 1,585 acres, near HGP-A in the Kapoho Section of the Kilauea Lower East Rift Zone, were already covered by a geothermal mining lease and were subsequently designated subzones under a "grandfather" provision of a 1984 Act.

An assessment of the geothermal potential in each County was conducted by a Geothermal Resource Technical Committee which did a literature search of all information collected and identified 20 geograhical areas where there was some documented indication of a geothermal resource. Seven of those ten areas had a 25 percent probability of having a temperature greater than 125°C at a depth of less than three kilometers. In late 1984, using the criteria provided, four of the seven areas were proposed as subzones: the 5,939-acre Kapoho Section and 5,519-acre Kamaili Section located in Agricultural and Conservation Districts in the Kilauea Lower East Rift Zone; and a 4,154-acre site in a Conservation District in the Haleakala Southwest Rift Zone on Maui.

In 1985, the BLNR, after a contested case hearing, designated 5,200 acres of land in the Kilauea Middle East Rift Zone as a subzone. The State exchanged this land with a private land owner interested in geothermal development.

TRUE/MID-PACIFIC VENTURE

The True Geothermal Energy Company of Casper, Wyoming, and Mid-Pacific Geothermal, Inc., also of Wyoming, initially entered into an agreement with the Estate of James Campbell to develop geothermal resources on Campbell land near Hawaii Volcanoes National Park and the Kilauea Caldera complex on land designated Conservation. The Environmental Impact Statement and concurrent Conservation District Use Application (CDUA) were submitted in 1982 for the exploration and development of 250 megawatts of geothermal resources. In approving the CDUA, the BLNR approved the project but for exploration only, and with nearly 40 conditions attached. The groups that had opposed this project appealed the BLNR decision. The Supplemental EIS and near-concurrent, revised CDUA in late 1985 reduced the scope to 100 megawatts of exploration and development in the State-owned land proposed for exchange. The contested case hearing on the revised CDUA was quite lengthy. In April 1986, the BLNR approved exploration to determine the existence of geothermal resources capable of providing up to 100 megawatts of electrical energy and to conduct actual development activities to produce up to 25 megawatts of electrical power for the purpose of satisfying the requirements for the Island and County of Hawaii. Included in the decision was approval to develop, in increments, up to a total of 100 megawatts provided certain reasonable conditions were first satisfied. The incremental 75 megawatts would be subject to ministerial approval, i.e., public hearings would not be required. The BLNR approval included 34 conditions, two of which removed about 15 percent of the total planned exploration and development area including sites that evidenced the best surface manifestations of a geothermal resource. However, the approval permits directional drilling.

This developer continues to be plagued by court actions. The Pele Defense Fund appealed certain State land-use decisions to the State of Hawaii Supreme Court claiming that geothermal development will violate Pele, the volcano goddess. In July 1987, the State Supreme Court unanimously rejected the claim. The issue was further appealed by the Pele practioners to the U.S. Supreme Court which decided in April 1988, that it would not review the case. The Pele group has recently filed another suit in federal court

which claims that the State breached their duty by exchanging ceded lands to promote geothermal development. They also claim the State got a bad deal in the earlier land swap.

True/Mid-Pacific has also indicated interest in developing up to 25 megawatts in the Southwest Rift of Haleakala on the Island of Maui.

BARNWELL INDUSTRIES

All geothermal wells in Hawaii to date have been drilled with a rig owned and operated by a Barnwell subsidiary. The Barnwell Industries group drilled three exploratory wells between 1980 and 1984. All three wells were close to the HGP-A well. While significant temperature anomalies were attained, none of the wells were considered producers. In 1985, Barnwell Industries announced that they had written down their geothermal properties by over 55 percent and that they were monitoring developments in the geothermal area but did not intend to make additional significant geothermal investments in the near future.

PUNA GEOTHERMAL VENTURE (PGV)

This venture has been the most successful in Hawaii. Their three wells drilled in 1981, 1982, and 1985 have all flashed abundant steam. However, the first two are currently capped because of mechanical problems. All the wells are located less than a half mile north of HGP-A.

In April 1986, PGV and the Big Island utility, HELCO, announced that they had concluded a geothermal purchase power agreement aimed at 25 megawatts by 1995. This agreement calls for the developer to furnish electricity, not steam, to the utility. It appears that this will be the practice in Hawaii. PGV has set up a schedule for providing the initial 12-1/2 megawatts by the end of this decade.

PGV has made an initial application to the County of Hawaii Planning Commission for a Geothermal Resources Permit which is basically a land use permit to perform geothermal development activity on lands categorized for agricultural use. The County has accepted an Environmental Impact Statement which PGV elected to prepare.

However, PGV's exploration and development activities have been on the back burner for about a year while the venture is going through a change in ownership. In April 1988, ORMAT Energy Systems bought out AMFAC Energy's 25% share of PGV. After GEO's failure to obtain financing to buy out Maxus Energy's Thermal Power Company, ORMAT announced in May 1988, that Maxus had agreed to sell Thermal's 75% interest in PGV to ORMAT.

THE STATE GOVERNMENT'S ACTIONS

The State of Hawaii's Board of Land and Natural Resources is responsible for reviewing requests for geothermal development activity within subzones lying in lands designated Conservation. Regulations are in place for requesting geothermal activity on Conservation lands. The individual Counties, typically through their Planning Commission assisted by the Planning Department, are responsible for considering and issuing Geothermal Resource Permits (GRP) in non-Conservation, i.e., Agricultural, Rural or Urban, lands. The County of Hawaii put their GRP regulations in place in 1986. The County of Maui has not yet held informational meetings on its regulations but no geothermal development delay is anticipated.

The State's Department of Health (DOH) is expected to put their geothermal air quality regulations into place in 1988. The 1987 State Legislature removed several statutory barriers to geothermal development. The most prominent was deletion of contested case (quasi-judicial) hearings requested by geothermal opponents during geothermal (quasi-legislative) public hearings relating to land use and geothermal development. The Legislature provided that the owner of the surface land does not have to compete in an auction process for a mining lease for geothermal resources under his land. Another bill allows geothermal direct use (non-electric) applications to be developed on non-Conservation land either within or outside of a designated Geothermal Resource Subzone.

In September 1987, Governor John Waihee established the Cable Advisory Board to determine what should be done concerning geothermal and cable development and what the State's role should be. This Board is chaired by a former Governor and includes private, academic, and government leaders in the State. In their January 1988 preliminary report, the Board noted that the development of 500 MW of geothermal energy on the Island

of Hawaii for transmission to Oahu was highly necessary and apparently feasible. The report offered that the geothermal and cable development should be undertaken as one project and should be a private sector undertaking. But aggressive State support is needed. The Board forwarded two draft bills to the Governor: one for a Public Authority to facilitate cable and geothermal development; and the other to establish a consolidated geothermal/cable development permit application and review process.

The bill for a Public Authority did not survive long. At its initial Senate hearing, the Oahu electric utility concerned about the potential for "public power" testified against the bill. The Senate committee chairman, who has otherwise been a strong advocate for geothermal and cable development, did not pass the bill because he felt it was premature.

The bill to consolidate the permiting process did pass after considerable legislative debate and redraft. The bill assigns the Department of Land and Natural Resources (DLNR) as lead agency to establish and administer the permitting process. It requires all State and County agencies to participate in the process. The process is to incorporate a number of features including: a list of all required permits; the role and functions of all participants; permit review and approval deadlines; and a consolidation permit application form. Certain permit streamlining functions are assigned to the DLNR.

The 1988 State Legislature also appropriate $3 million, to be matched by the private sector, for geothermal exploration and for the expansion of facilities for commercial-scale geothermal direct-use applications.

THE INTER-ISLAND CABLE SYSTEM

Geothermal is the State's only major, mature baseload source of alternate energy. The resource is predominantly on the Big Island and is believed to be in excess of 1,000 megawatts, far in excess of that island's projected long-term demand. Over 80 percent of the State's total present peak demand of about 1,300 megawatts is located on Oahu. Oahu is separated from the Island of Hawaii by a distance of 240 kilometers of mostly ocean, and ocean depths of at least 2,100 meters. No high voltage transmission cable has ever been installed under these conditions.

In 1981, the Hawaii State Legislature appropriated funds for a preliminary analysis of the feasibility of a cable system. In 1982, the U.S. Department of Energy entered the program. Currently, the State has appropriated almost $5 million for the 500 megawatt Hawaii Deep Water Cable program and the U.S. Congress is expected to appropriate a total of $22 million to see the program through an at-sea test deployment of a surrogate cable in the deepest part of the projected route in 1989.

Generally, State funds have been used for Hawaii-specific portions of the program: integration of the cable with existing grids on Oahu, Maui and Hawaii; economic analysis and impact; legal, institutional and financial issues; environmental analysis; cable environmental tests; public information; and overland and at-sea route surveys. The Federal portion includes the cable itself, cable vessel and cable handling equipment.

At present (May 1987), the program has progressed to the following steps:

- o An environmental assessment has been prepared.
- o A 6,000 foot length of the selected cable design has been fabricated and mechanical and electrical tests in the laboratory are near complete.
- o Issues concerning the cable integration with the existing utility grid have been identified and quantified.
- o A preferred cable route has been identified, detailed ocean bottom surveys are near complete, and overland routes identified.
- o Plans are being developed for an at-sea test in 1989, of a 5-mile long cable with dynamic characteristics comparable to the selected cable.
- o Design concepts for cable vessel control and operational equipment is complete.
- o The legal and permitting issues have been identified.

- o An economic analysis is in progress. The capital cost estimate for the system is $475 million (1986 dollars). The economic feasibility is dependent on the avoided cost of the Oahu utility, the Hawaii Electric Company (HECO). Since HECO is over 98 percent dependent on petroleum for its present generation, the cable economics are highly dependent on petroleum cost projections. The above assumes that the ratepayer on Oahu will absorb the costs associated with the cable as well as the geothermally-produced electricity.

The impetus for installing the cable is the transportation to Oahu of electricity developed from the Island of Hawaii's natural energy resources, predominantly geothermal. However, the cable will satisfy a more encompassing objective, providing essentially one electrical grid for the State's major demand and supply centers. Without this expanded grid it will be extremely difficult for the State to achieve any significant degree of electrical energy self-sufficiency.

CONCLUSION

The State government has removed many of the barriers to geothermal development in Hawaii. The State continues to aggressively facilitate commercial development. Although private sector progress has been slow, the State anticipates steady progress toward the attainment of 600 megawatts (gross) of geothermal energy development in this century.

Potentially, the Island of Oahu could use 500 megawatts of electricity produced from geothermal resources on the Island of Hawaii. The technical and environmental feasibility of a 500 megawatt submarine cable between the islands is being demonstrated.

The economic feasibility of developing the estimated $475 million cable system and $1.2 billion to produce 500 megawatts of geothermal energy is dependent on the Oahu utility's avoided costs which in turn is highly dependent on the cost of imported petroleum.

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